Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – June 2024

Programme Name: B.Tech(ME)

Semester: IV

Subject Code: UG11T3406

Subject Name: Marine Heat Engine & Air Conditioning

Date: 05.06.2024 Max Marks: 70

Duration: 03 Hrs Pass Marks: 35

Section- A

[10 x 1 = 10 Marks] MCQ	**A**	**B**	**C**	**D**
(1) Steam turbines are used for	Large marine propulsion	Electric power generation	Direct drive of fans, compressors, pumps	All of these
(2) The discharge of steam in a convergent-divergent nozzle _____ after the throat	Remains constant	Decreases	Increases	None of these
(3) A steam nozzle converts	Heat energy of steam into kinetic energy	Kinetic energy into heat energy of steam	Heat energy of steam into potential energy	Potential energy into heat energy of steam
(4) The heat loss in a boiler takes place in the form of	heat carried away by flue gases	moisture present in fuel and steam formed by combustion of hydrogen in fuel	radiation	All of these
(5) The ratio of heat utilised to produce steam a the heat liberated in furnace is known as	boiler effectiveness	boiler evaporative capacity	factor of evaporation	boiler efficiency.
(6) Vacuum in the Fresh Water Generator is produced by	Main Air Compressor	Main Engine	Convergent Divergent Nozzle	Lube oil Pump
(7) Gas turbine performance majorly depends on	compressor efficiency	calorific value of fuel used	nozzle efficiency	none of these
(8) In gas turbine, intercooler is placed	before low pressure compressor	in between low pressure compressor and high pressure compressor	in between high pressure compressor and turbine	None of these
(9) The temperature of air recorded by a thermometer, when it is not affected by the moisture present in the air, is called	Wet bulb temperature	Dry bulb temperature	Dew point temperature	None of these

(10) The air pressure inside the accommodation should always be maintained	at a slightly positive pressure than the atmospheric pressure	at a slightly negative pressure than the atmospheric pressure	equal to atmospheric pressure	depending on the temperature outside

Section-B

[5 x 2 = 10 Marks] - Short Answer Type Questions
(11) Explain degree of reaction of a steam turbine
(12) Define equivalent evaporation of boiler
(13) Draw block diagram of gas turbine plant with intercooler, reheat and regeneration
(14) Explain practical vapour compression cycle on T-s diagram
(15) Define evaporative cooling

Section- C : 7 Long Questions-Answer Any 5 (05 X 10 Marks)

(Note: Use of steam table is permitted as required in Section C)

16.The velocity of steam leaving the nozzles of an impulse turbine is 900 m/s and nozzle angle is 20^0. The blade velocity is 300 m/s and the blade velocity coefficient is 0.7, calculate for the mass flow rate of 1 kg/s and symmetrical blading: - (i) the blade inlet angle(ii)the driving force on the wheel(iii)the axial thrust(iv)the diagram power(v) the diagram efficiency. (Marks 10)

17(a).A boiler trial data is given as below: -
Steam generation = 16 bar dry saturated.
Coal consumed = 10,000 kg
Rate of steam = 2500 kg per hour
Feed water temperature = 27 deg C
Heating surface area = 3000 sq m
Total grate area = 4 sq m
Calorific value of coal = 28,000 kJ/kg
Find out: - (i) Equivalent evaporation, (ii) Boiler efficiency and (iii) Evaporation factor. (Marks 2+2+1=5)

17. (b)A surface condenser operating at pressure of 24 kN/m2 condenses 1.8 tonne of steam per hour. The steam enters the condenser with dryness fraction of 0.98 is condensed but not undercooled. Cooling water enters the condenser at temperature of 21 deg C and leaves at 57 deg C. Determine the flow rate of the cooling water. (Marks 5)

18. The pressure in the evaporator of an ammonia refrigerator is 1.902 bar and the pressure in the condenser is 12.37 bar. Calculate the refrigerating effect per unit mass of refrigerant and the COP_{ref} if dry saturated vapour delivered to the compressor and after compression it has temperature of 65^0C. The liquid after condensation is undercooled by 10 K. Refer to the properties of ammonia shown in the table. (Marks 5+5)

P	T	Vg	hf	hg	Sf	Sg	Cp of liquid ammonia = 4.82 kJ/kgK
(bar)	(^{0}C)	m^3/kg	kJ/kg	kJ/kg	kJ/kgK	kJ/kgK	
1.902	-20	0.624	89.8	1420	0.368	5.623	
12.37	32	0.104	332.8	1469.9	1.235	4.962	

19. Explain what do you mean by Compounding of Steam turbines along with explaining the following types.

(i) Pressure Compounding of Impulse Turbine

(ii) Pressure Velocity Compounding of Impulse Turbine. (5+5 Marks)

20.(a) Explain the Heat Balance in a Boiler depicting the various forms in which the heat input from the fuel is utilized. (5 Marks)

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(b). Steam is generated in a boiler at 30 bar 300oC at the rate of 11 kg/s with feed water entering economiser at 100oC. During one hour test 5000 kg fuel is used in boiler. Calorific value of fuel is 35000 kJ/kg. For the feed water being supplied to boiler to be at 27°C determine;
(i) the equivalent evaporation per kg of fuel
(ii) the boiler efficiency
(iii) the percentage of fuel energy utilised in economiser
Enthalpy of steam at 30 bar, 300oC = 2993.5 kJ/kg.
Enthalpy of feed water at 27oC = 112.86 kJ/kg (2+2+1 Marks)

21. Sketch and describe a Marine Refrigeration System showing cold rooms maintained at different temperatures. (10 Marks)

22. A gas turbine has an overall pressure ratio of 5 & a maximum cycle temperature of 550 C. The turbine drives the compressor and an electric generator. The ambient temperature is 20 C & the air enters the compressor at the rate of 15 kg/s; the isentropic efficiencies of the

compressor & the turbine are 80 & 83%. Neglecting changes in Kinetic energy, the mass flow rate of fuel, & all pressure losses, calculate:

(i) The power output;

(ii) The cycle efficiency;

(iii) The work ratio.

For compression Process: cpa=1.005 kJ/kgK and $\gamma = 1.4$ For the combustion and expansion processes cpg=1.15 kJ/kgK $\gamma = 1.333$

(3+3+4 Marks)